

# NAVAL HEALTH RESEARCH CENTER

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## *SURVEY OF PHYSICALLY DEMANDING TASKS OF U.S. NAVY EXPLOSIVE ORDNANCE DISPOSAL (EOD) PERSONNEL*

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Human subjects participated in this study after giving their free and informed consent. This research has been conducted in compliance with all applicable Federal Regulations governing the Protection of Human Subjects in Research.

## Summary

Problem. Select U.S. Navy commands have the authority to establish physical fitness standards higher than those of the general fleet. There was a desire in the Explosive Ordnance Disposal (EOD) community to have gender-neutral standards for the semiannual Physical Readiness Test (PRT) that reflected the occupational demands placed on an EOD technician. To determine the physical requirements of EOD tasks, it was first necessary to identify the physically demanding tasks that the technicians perform.

Objective. The primary objective of this study was to identify physically demanding tasks performed during EOD operations and to rank them according to difficulty to perform, frequency of performance, and importance to overall mission success. A second objective was to identify specific abilities that contribute to success as an EOD technician.

Approach. Subject matter experts (SME) from training and operational EOD units were interviewed regarding the tasks they perform or had performed as EOD technicians. Based on these interviews, we developed a preliminary inventory of the physical tasks. Copies of the inventory were sent to the SMEs for review and comment. Following an iterative review and revise process, the inventory was judged comprehensive and technically accurate. From the inventory, we developed a three-part questionnaire based on the tasks. Part one contained task statements such as: *"Lift SCUBA tanks above head to pass to personnel aboard support craft."* EOD technicians rated each statement from one to seven (least to most) on difficulty to perform, frequency of performance, and importance to overall mission success. The three individual scores for these dimensions were summed for each statement to obtain a "composite" score. The composite score was calculated to mitigate the effect of extremely difficult activities that are performed infrequently or are of little consequence to mission success. Part two of the questionnaire involved identifying specific tasks that (1) required the most muscular strength, (2) required the most muscular endurance, (3) were the most physically demanding tasks that are performed routinely, and (4) were the most physically demanding tasks that were ever performed. A final question in this section asked what task the technician believed all members of an EOD team should be able to perform. The final section of the survey asked the technicians to rate 24 abilities (e.g., manual dexterity, memorization) into categories of "more important," "important," and "less important" to mission success. The responses to the abilities questions then were ranked ordinally within the three categories.

Results. A total of 84 technicians from EOD Groups ONE and TWO completed the survey. The years of EOD experience of this sample ranged from 1 to 26.5 years, with a mean ( $\pm$  SD) of 9 ( $\pm$  2) years. Twenty-nine of the 84 participants (34.5%) reported having 10 or more years of EOD experience. The top two rated tasks on the composite score were logistics tasks of loading diving equipment onto a support craft. The three tasks that respondents believed every EOD team member should be able to perform were partner rescues.

Conclusions. To our knowledge, these data comprise the most comprehensive analysis of the physical demands of actual EOD tasks performed to date. Logistics tasks appear to be among the most physically demanding and frequently performed tasks. These data provide a basis for developing job-based physical fitness standards and may be used to develop task-oriented physical training programs for EOD technicians.

## Introduction

Few U.S. Navy personnel are Explosive Ordnance Disposal (EOD) qualified. Today, there are only about 1,000 of these well-trained and highly motivated professionals serving in this community. EOD personnel serve in mobile units, shore and shipboard detachments, training and evaluation units, a technology development center, and on staff at EOD Groups ONE and TWO. EOD units are deployed throughout the world, providing support for both at-sea and shore-based operations.

The EOD mission is to eliminate hazards from ordnance that jeopardize operations conducted in support of the National Military Strategy by providing combat ready EOD forces to the fleet. This includes detecting, identifying, rendering safe, and disposing of explosives on land or at sea under any type of environmental condition. This extremely broad mission requires that technicians be trained in the full range of known ordnance, from simple blasting caps to exotic chemical, biological, or nuclear weapons, and in unconventional ordnance, such as improvised explosive devices (IED) (e.g., pipe bombs, satchel charges, and car bombs) that are not held in military or civilian inventories. Further, EOD personnel must be capable of performing a variety of insertion techniques (e.g., small boat, SCUBA, parachute, fast rope) to reach remote locations.

Navy EOD technicians attempt to reduce the risk involved in ordnance disposal by employing formalized procedures. They are trained extensively in the technical characteristics of a broad range of known and improvised ordnance, and they are required to follow established procedures for specific devices. The approach an EOD team selects when rendering safe an explosive device is guided by the principle of minimizing exposure of personnel to risk (e.g., no more people than necessary may enter the blast/fragmentation zone). This principle can mean that a single technician can be required to carry heavy equipment loads to a site.

In addition to technical training in handling of explosives, Navy EOD technicians must be qualified as scuba and mixed-gas divers. Diving can be strenuous, especially in cold water or when performing repetitive tasks for long durations. Perhaps equally demanding are the logistic requirements of diving. Diving equipment is heavy and often must be transported by hand from storage locations to a vehicle or vessel and then back when the task or deployment is complete.

One of the guiding EOD principles is to develop creative solutions to problems using mechanical advantages (e.g., winches, block and tackle, and vehicles) whenever possible to minimize the physical effort required for a task. Occasionally, situations arise in which there is insufficient equipment or time to perform a task in the optimal manner. It is these instances that can place the greatest physical demands on EOD technicians. EOD technicians must be prepared physically to perform their duties at all times despite these contingencies and to maintain the required high level of operational and technical readiness.

As with other select naval commands (e.g., Naval Special Warfare, Search and Rescue), EOD commands are permitted to set their own Physical Readiness Test (PRT) standards. These commonly include additional tasks like pull-ups, swimming, and higher standards than the fleet.

Key EOD commanders and senior technicians believe that the physical requirements of EOD tasks warrant these higher standards. This study was conducted to address concerns regarding justification for existing EOD PRT standards. The goal of the study was to provide basic information that would allow an objective estimation of and, if possible, quantification of the physical demands placed on EOD personnel while performing their duties. A secondary goal was to select components and standards for the EOD PRT that would be gender neutral, thereby establishing a single set of standards for all technicians based on the physical requirements of the job.

## **Methods**

This research involved 10 major steps. The methodology has been used successfully in the past with U.S. Navy Sea-Air-Land (SEAL) physically demanding operations (Prusaczyk et al., 1995a) and SEAL Delivery Vehicle crew position tasks (Prusaczyk et al., 1995b). The following sections describe each of the project phases in detail.

### **Conducted Interviews with EOD Subject Matter Experts (SME)**

The project began with a series of informal, open-ended interviews with senior EOD technicians from mobile units and EOD Group ONE staff located in San Diego, CA. The next step was to conduct a site visit to the EOD Training and Evaluation Unit ONE (EODTEUONE) at Naval Magazine Lualualei, HI. Approximately 15 EODTEUONE instructors and command personnel were interviewed during the visit. In conjunction with the visit, the research team participated in a joint EOD/U.S. Army Special Forces air operations exercise. On another occasion, a member of the research team participated in a special nuclear response training exercise (Operation Broken Arrow) conducted near Albuquerque, NM, to obtain experience with EOD tasks performed while wearing nuclear, biological, and chemical protection ensembles and the MCU 2/P respiratory protective mask. The exercise simulated a land range clearance and a nuclear render safe procedure (RSP).

A second series of interviews and observations was conducted with EOD Group TWO personnel and staff at NAB Little Creek, VA. A site visit was made to the EOD Training and Evaluation Unit TWO (EODTEUTWO) at Fort Story, VA. EODTEUTWO personnel were interviewed and the research team inspected special facilities developed by EOD Group TWO to support high-fidelity training.

The objective of all interviews and observations was to identify the EOD tasks and activities that involve the greatest physical demands. Personnel were asked to describe the most physically demanding tasks or activities that they had performed as an EOD technician. Comments were recorded for later review and analysis. In all, more than 70 EOD SME were interviewed. A special effort was made to interview the most experienced EOD personnel still on active duty.

### **Reviewed EOD Training Documents**

The research team reviewed a limited number of EOD training documents, bulletins, and course descriptions. These materials provided little information regarding the physical requirements of tasks but were invaluable in identifying procedural and equipment issues that could influence task performance.

### **Developed a Preliminary List of the Most Physically Demanding EOD Activities**

Based on the interview notes and research team observations, a draft list of the most physically demanding EOD tasks and activities were prepared. All task statements were phrased in the same format to facilitate comparison among items. Statement began with an action verb followed by the object of the verb and how or why the task was performed. A typical statement might be: *"Lift SCUBA tanks above head to pass to personnel aboard support craft."*

The draft list contained 65 task statements organized into the broad categories of dive operations, marine mammal systems, air operations, ordnance, IED, and other activities. The last category contained tasks such as emergency rescues, logistics, and combat tasks. The list, as designed, could be categorized further according to the frequency with which the task was performed. The categories included tasks that are "routinely performed," such as logistics tasks and loading equipment aboard a ship, and tasks that might be "infrequently performed," (if ever) during an EOD career, such as carrying bombs through a swamp or rescuing a disabled partner.

### **SME Reviewed the Draft List**

The draft list of tasks was submitted for review to representatives of EOD Groups ONE and TWO. A total of 15 experienced EOD technicians and officers reviewed the list, returning comments on feasibility, accuracy, and specificity of the task statements. For example, when reviewing task feasibility, a reviewer's comments might indicate that a task is typically performed by two or three people, rather than a single technician. Errors or variations in the terms used to describe equipment and procedures were corrected. Finally, exact weights of equipment or loads and the distances these loads typically are carried either were measured or specified by the reviewers.

### **Modified the Draft List Using SME Comments**

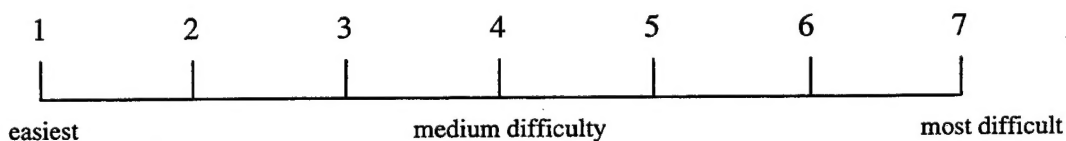
The research team and senior EOD personnel conducted discussions to determine the need for further modifications of task statements. Following the discussions, the final list of the most physically demanding EOD activities was prepared, reviewed, and approved. The final list contained 64 task statements.

## Developed Questionnaire and Conducted Survey

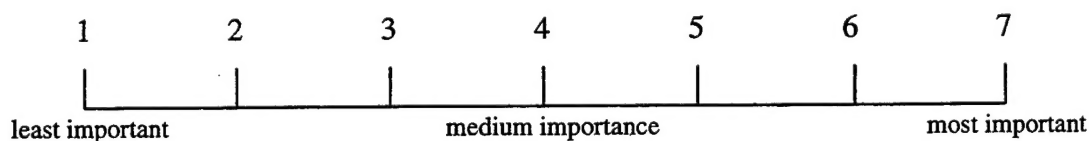
A self-administered questionnaire was constructed for distribution to a sample of experienced EOD personnel. Survey questionnaires were sent to project liaisons at EOD Groups ONE and TWO who coordinated the participation of the EOD technicians and administered the survey.

The questionnaire was composed of three sections. The first included the final list of 64 physically demanding activities with four questions asked about each task statement. First, the respondent was asked whether he or she had ever performed the task or one very similar (a yes/no question). Second, three questions regarding difficulty, importance, and frequency of performance were asked about each task. Personnel answered using a 7-point Likert scale (Figure 1) that was reproduced at the top of each page of the questionnaire.

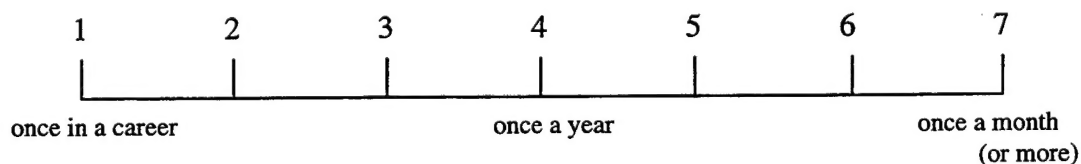
- A. How physically DIFFICULT is it to perform the mission at a satisfactory level compared to all other missions performed?



- B. How IMPORTANT is it for an EOD technician to be able to perform the mission compared to all other activities?



- C. How FREQUENTLY is the activity performed compared to all other activities?



**Figure 1. 7-point Likert scale with questions.**

In part two of the questionnaire, the technicians were asked seven questions about the listed tasks. The technicians identified the one task that requires the most muscular strength, the one that requires the most muscular endurance, and the one that was the most physically demanding. Each question was asked independently about the tasks that are performed routinely and tasks that had ever been performed. A final question was asked to determine which of the tasks the technician would want every person in the EOD team to be able to perform.

The final section of the questionnaire solicited ratings of the abilities required to be a successful EOD technician. This technique was used to identify the key abilities for success in Naval Special Warfare (NSW) tasks (Prusaczyk et al., 1995a; Prusaczyk et al., 1995b). Participants were provided an envelope containing 24 "ability" cards, with one ability (e.g., strength, stamina, depth perception) listed and described on each. The titles and descriptions were derived from Fleishman and Quantance (1984). Also in the envelope were three "category" cards labeled "Less Important," "Important," and "More Important." The abilities and categories, including the written description of the ability, are included in Appendix A.

The participants were asked to place the three category cards on a table in front of them, then to distribute the ability cards into the categories that best reflected the relative importance of each ability to successful job performance as an EOD technician. Participants then arranged the cards within each category in order of relative importance, with the most important ability on top. The deck then was reassembled and returned to the envelope for subsequent analysis.

This sorting procedure resulted in a rank ordering of all abilities based on the personal experience and perspective of each technician. The tabulated data from all technicians resulted in a list of the abilities and the average order of importance to successful job performance. The rank order of the category cards were tabulated along with the orders of the abilities making it possible to identify category breaks in the aggregate data.

### **Analyzed the Data**

Completed surveys and the accompanying decks of ability cards were returned and the data were entered into Excel<sup>®</sup> (Microsoft, Inc.; Redmond, WA) spreadsheets for analysis. Mean values were obtained for each task statement for each of the questions on frequency of performance, difficulty to perform, and importance to mission success. The task statements then were ranked in terms of the scores on the three questions. Mean values for the questions were subsequently combined to form a fourth dimension, a "composite" score on which all tasks could be compared. The composite score weighted difficulty, importance, and frequency measures equally.

Although there are many methods for determining the contribution of multiple dimensions to a composite (e.g., differential weighting), equal weighting was selected for the purposes of this study. It was believed that the composite score provided the most credible way to compare across the tasks for the purpose of this study. Not all EOD tasks were included in the inventory, only those reported to be among the most physically demanding. That a task is "difficult to perform" was one of the criteria for inclusion in the survey. However, relying exclusively on

difficulty to perform could place too great an emphasis on extremely difficult tasks that are relatively unimportant and/or performed very infrequently. Using the composite score avoided a reliance on "difficulty to perform."

Finally, the order of the ability and category cards was recorded for each respondent and descriptive statistics were computed for the entire sample.

## **Results and Discussion**

### **Respondents**

A total of 84 technicians from EOD Groups ONE and TWO completed the survey. The mean ( $\pm$  SD) EOD experience of this sample was 9 ( $\pm$  2) years, ranging from 1 to 26.5 years. Twenty-nine of the 84 participants (34.5%) reported 10 or more years of EOD experience.

### **Part One: Task Analysis**

Appendix B contains the complete inventory of tasks in order of presentation in the questionnaire. The appendix also lists the mean score for each task statement on the difficulty to perform, importance to mission success, frequency performed, and the composite score.

### **Difficulty to Perform**

Table 1 presents the top 10 tasks rated the most difficult to perform. The data in Table 1 indicate that the most difficult task was a 500-yard surface swim against current and swells while wearing SCUBA gear; a task 75% of the sample had performed. The second most difficult activity involved the disposal of a large number of World War II bombs on a remote island in the Pacific Ocean; however, only 9% of respondents reported experience with this or a similar disposal task requiring that amount of manual labor.

The third most difficult task reflects a relatively new EOD responsibility during low-intensity conflict. EOD Group TWO commanders are actively expanding the EOD mission to include participation with NSW and other specially trained elements in joint operations. They believe that future conflicts will be fought primarily by special operations units and that the EOD community will contribute substantively to these efforts. This new mission, however, will place additional requirements on EOD personnel for physical conditioning and tactical training.

Table 1. Top 10 Tasks: Difficulty to Perform.

Mean Difficulty	Task Statement (proportion of sample who have performed the task)
6.17	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially inflated life vest, and fins in 4-foot swells and against a 1-knot current. (75%)
6.12	Drag one hundred 250-kg bombs through a swamp (distance approx. 100 feet) using block and tackle with another EOD technician. (9%)
6.01	Run 1 mile over beach and sand dunes, sprinting from cover to cover with 2-min rests between the 20- to 50-yard sprints, while wearing a 40-lb pack and carrying an M-16, in 85°F temperature and high humidity. (36%)
6.00	Conduct a moving Jackstay grid search at a depth of 50 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period). (82%)
5.99	Conduct biological emergency response clearance (RSP/detox) over uneven terrain for 2 hr in 70°F temperature and low humidity while wearing toxicological agent protective (TAP) suit (with ice vest) and mask. (71%)
5.98	Carry a 40-hp outboard motor (approx. 110 lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), with a partner, in preparation for deployment. (57%)
5.92	Set-up equipment (stakes, lines, etc.) and haul a 2,000-lb mine onto the beach using blocks, tackle, and four additional EOD technicians (no truck available). (82%)
5.90	Carry a footlocker containing EOD technical manuals (approx. 220 lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), with a partner, in preparation for deployment. (91%)
5.89	Carry collapsible chest containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb). (88%)
5.89	Carry a disabled partner (approx. 185 lb) over shoulder (fireman's carry) to safety (e.g., from blast or toxic fumes, distance approx. 100 yards). (40%)

The fourth most difficult task to perform is a more traditional EOD task, underwater clearance. This operation is performed routinely under unusually difficult conditions in Florida's Inland Waterway. This is a task performed annually to remove ordnance and debris from a channel near a target range.

The fifth task involves clearance and RSP while wearing a toxicological agent protective (TAP) suit. While the task is not difficult by itself, the thermal stress the technician experiences during the activity makes it physically demanding. Technicians reported that, under certain environmental conditions, working for 2 hours in a TAP suit might be impossible to complete. This type of work is so difficult that, during training, technicians often are not required to wear the respiratory protective masks during warm weather.

Four of the remaining five tasks require lifting and carrying heavy weights. Three of the tasks are logistics-related activities performed as a unit deploys aboard ship and one task involves carrying a disabled partner to safety. The remaining task, one performed by 82% of the EOD technicians, involves the beaching of a surface mine using manual remote-beaching gear, a task similar to the disposal of old ordnance (task statement #2).

#### Importance to Mission Success

Table 2 presents the top 10 tasks rated most important for an EOD technician to perform. The tasks listed in Table 2 are of two types: emergency rescue actions (including the rescue task listed last in Table 1) and activities that are central to the traditional EOD mission. The top five tasks are all rescue actions, four involving rescuing a disabled dive partner and the other a rescue on land. Between 29% and 49% of the respondents reported that they have had to perform these or similar tasks at least once during their EOD careers.

The tasks ranked fifth through tenth are standard EOD activities, representing some of the core responsibilities of EOD.

Table 2. Top 10 Tasks: Importance to Mission Success.

Mean Value	Task Statement (proportion of sample who have performed the task)
6.87	Rescue disabled dive partner weighing 185 lb from a depth of 60 feet (both you and partner wearing twin 80s. (29%)
6.60	Swim on calm sea surface a distance of 100 yards with disabled dive partner weighing 185 lb who is wearing an inflated life preserver. (47%)
6.47	Pull a disabled diver (weighing approx. 180 lb) into a Mk-5 boat, after releasing the diver's twin 80s and 24 lb of lead weights, without assistance. (49%)
6.39	Carry a disabled partner (approx. 185 lb) over shoulder (fireman's carry) to safety (e.g., from blast or toxic fumes, distance approx. 100 yards). (40%)
6.27	Pull a disabled diver into a Mk-5 boat, with the diver wearing a wet suit, a set of twin 80s, and 24 lb of lead weights (approx. 280 lb total), with assistance. (49%)
6.22	Swim 150 feet to a floating mine, in 4-foot swells with a charge (20-lb), attach the charge, and swim away quickly to waiting "horse collar" for helicopter retrieval. (67%)
6.21	Perform a limpet inspection of a Spruance-class destroyer, at night while carrying a 10-lb bag of tools, with partner (approx. 1- to 3-hr duration). (91%)
6.10	Set-up and operate x-ray equipment on suspected IED (with moderate access). (99%)
6.08	Dive to a depth of 60 feet to bring then attach a Mk II lift balloon to a bottom mine, then return to boat against a 1-knot current in 4-foot seas, remove UBA and weights, and pass them to person onboard; then, pull self aboard. (83%)
6.02	Don protective ensemble then approach IED aboard ship (approx. distance 300 feet with two ladders to climb) carrying x-ray equipment and tool kit. (76%)

### Frequency Performed

Table 3 presents the top 10 tasks rated as the most frequently performed by this sample of EOD technicians. The tasks in Table 3 reflect the central role of diving in Navy EOD operations. Five of the tasks involve diving-related activity. The two most frequent tasks, performed by 100% of the sample, are logistics tasks associated with diving.

Table 3. Top 10 Tasks: Frequency Performed.

Mean Value	Task Statement (percentage of sample who have performed the task)
6.42	Carry diving equipment from truck or dive locker to a small boat (6 trips at 60 lb each). (100%)
6.37	Lift SCUBA tanks (twin-80s weighing 80 lb), pass to eye level to pass to personnel aboard support craft. (100%)
5.19	Set-up and operate x-ray equipment on suspected IED (with moderate access). (99%)
5.11	Perform a limpet inspection of a Spruance-class destroyer, at night while carrying a 10-lb bag of tools, with partner (approx. 1- to 3-hr duration). (91%)
4.77	Perform IED response wearing full protective ensemble and carrying a J-rod and a .50 caliber dearmers (one in each hand at arm's length from body), a firing reel, and tool kit a distance of 300 feet over level terrain in 85°F temperature and low humidity. (83%)
4.65	Enter water from boat wearing twin 80s to verify correct YB action for animal reward (to approx. 40-foot depth) and return to boat (pulling self aboard), 20 times in a 2-hr period. (30%)
4.63	Carry equipment bags (with sledges, stakes, vests, etc.--weighing 60 lb) while trailing the remote pull line with additional equipment bag attached (approx. 1,000 feet). (82%)
4.58	Unload two hundred fifty 40-lb cartons of frozen marine mammal food (10,000-lb total) from truck to storage with six other EOD technicians (bucket-brigade style). (24%)
4.51	Serve as fast rope master at door of helicopter for three drops during a day, pulling 50-lb rope into helo between drops. (22%)
4.39	Dive to a depth of 60 feet to bring then attach a Mk II lift balloon to a bottom mine, then return to boat against a 1-knot current in 4-foot seas, remove UBA and weights, and pass them to person onboard; then, pull self aboard. (83%)

Other frequently performed tasks include such primary EOD activities such as IED responses and hull inspections for limpet mines. Also on the list are two marine mammal tasks that, while not performed by large numbers of technicians, are performed very frequently by those responsible for the marine mammal systems.

Table 4. Top 10 Tasks: Composite Score.

Mean Value	Task Statement (percentage of sample who have performed the task) Rankings on Difficulty, Importance, and Frequency
16.74	Lift SCUBA tanks (twin-80s weighing 80 lb) to eye level to pass to personnel aboard support craft. (100%) Difficulty: #51; Importance: #64; Frequency: #2
15.82	Carry diving equipment from truck or dive locker to a small boat (6 trips at 60 lb each). (100%) Difficulty: #62; Importance: #21; Frequency: #1
15.62	Perform IED response wearing full protective ensemble and carrying a J-rod and a .50 caliber dearmmer (one in each hand at arm's length from body), a firing reel, and tool kit a distance of 300 feet over level terrain in 85°F temperature and low humidity. (83%) Difficulty: #26; Importance: #21; Frequency: #5
15.55	Dive to a depth of 60 feet to bring then attach a Mk II lift balloon to a bottom mine, then return to boat against a 1-knot current in 4-foot seas, remove UBA and weights, and pass them to person onboard; then, pull self aboard. (83%) Difficulty: #32; Importance: #9; Frequency: #10
15.54	Perform a limpet inspection of a Spruance-class destroyer at night while carrying a 10-lb bag of tools, with partner (approx. 1- to 3-hr duration). (91%) Difficulty: #50; Importance: #7; Frequency: #4
15.05	Carry collapsible chests containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb). (88%) Difficulty: #9; Importance: #30; Frequency: #29
15.01	Don protective ensemble then approach IED aboard ship (approx. distance 300 feet with two ladders to climb) carrying x-ray equipment and tool kit. (76%) Difficulty: #38; Importance: #10; Frequency: #12
14.98	Swim on surface a distance of 500 yards wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current. (75%) Difficulty: #1; Importance: #33; Frequency: #38
14.93	Carry a footlocker containing EOD technical manuals (approx. 220 lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), with a partner, in preparation for deployment. (91%) Difficulty: #8; Importance: #41; Frequency: #25
14.86	Conduct a moving Jackstay grid search at a depth of 40 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period). (82%) Difficulty: #4; Importance: #25; Frequency: #34

## Composite Score

Table 4 presents the top 10 tasks ranked in terms of the composite score. The maximum possible value of the composite score is 21 (i.e., 7-point maximum on each of the three other dimensions). Also provided in Table 4 are the rankings of each task on the difficulty, importance, and frequency dimensions.

This score reflects the combination of difficulty, importance, and frequency, for each task in the inventory. For example, the task listed previously in Table 1 as the second most difficult task to perform was rated as 63<sup>rd</sup> out of the 64 tasks in importance and 57<sup>th</sup> in frequency. Several respondents commented that the technicians performing the task should have waited for assistance, preferably someone with a truck. Even the technician who reported the task agreed that there was no urgency to remove the bombs, and that it was better to move the bombs by hand than to wait days for assistance to arrive. The task, while difficult, was neither important nor does it occur frequently. By combining the scores on the three dimensions, the task ranked only 60<sup>th</sup> on the composite score.

All the tasks listed in Table 4 were ranked among the top 10 on at least one of the three dimensions but, in many cases, the differences in rankings on the three lists are extreme. For example, the task listed as the number one task on the composite score, *"Lift SCUBA tanks to eye level to pass to personnel aboard support craft,"* is not considered very difficult compared with all of the other tasks (51<sup>st</sup>), nor was it considered very important that all technicians be able to perform this lifting task (64<sup>th</sup>); however, the task is performed very frequently. Lifting SCUBA tanks in this manner is second only to carrying the tanks and other dive equipment from the dive locker or a truck or a dock to be loaded aboard. All of the respondents in this study reported having performed these tasks very frequently. Four of the top 10 most difficult tasks to perform also are included on the list of the top 10 composite scores. These include the 500-yard surface swim (#1 on difficulty, #8 on composite), the moving Jackstay grid search with current (#4 on difficulty and #10 on composite), carrying a footlocker full of technical manuals aboard a ship (#8 on difficulty, #9 on composite), and the similar task of carrying collapsible chests of equipment aboard, in preparation for a deployment (#9 on difficulty, #6 on composite).

The 10 tasks listed in Table 4 provide a synopsis of the primary activities and responsibilities of EOD technicians: 70% percent of the tasks involve carrying heavy loads; 60% of the tasks are diving-related; and 40% of the tasks involve working with explosives. It is important to note that these categories are not mutually exclusive. In fact, the emphasis on diving and the requirement for heavy lifting are closely related, because diving requires equipment that must be transported every time it is used. The most senior member of the EOD community noted that diving and working in protective gear are the factors most unique to EOD physical activity compared with more conventional Navy activities.

## **Part Two: Specific Activities**

This section of the questionnaire dealt with those specific activities that required the most strength and endurance and were (1) routinely performed, (2) ever performed, and (3) those that

every EOD technician should be able to perform. The top three rated tasks for each of the categories are presented in Table 5.

There is a recurring pattern of tasks that appears in Table 5. The top three tasks performed regularly requiring muscular strength and two of the top three most physically demanding tasks regularly performed are logistics tasks. The top task in both categories involves loading SCUBA gear into a support craft, a task that all respondents have performed (see Table 3). The top task for muscular endurance, both ever performed and regularly performed, is a swimming task. Again, a logistic task is ranked as second for tasks requiring muscular endurance that had ever been performed. These tasks reflect the reliance on equipment (diving gear and ordnance disposal) and documentation (technical manuals) required for successful EOD operations.

Table 5. Top three specific activities requiring most muscular strength and endurance performed regularly and ever performed.

Task #	Task Statement	# Respondents
<b>Muscular Strength, Performed Regularly</b>		
1	Lift SCUBA tanks (twin-80s weighing 80 lb) to eye level to pass to personnel aboard support craft.	29
2	Carry diving equipment from truck or dive locker to a small boat (6 trips at 60 lb each).	6
62	Carry collapsible chests containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb).	5
<b>Muscular Strength, Ever Performed</b>		
47	Set-up equipment (stakes, lines, etc.) and haul a 2,000-lb mine onto beach using blocks, tackle, and four additional EOD technicians (no truck available).	13
62	Carry collapsible chests containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb).	10
45	Drag a Zodiac rubber boat with twin 25-hp motors attached and four 60-lb packs inside, through the surf zone and onto the beach 100 feet, then turn the boat around, with three other EOD technicians.	7
<b>Muscular Endurance, Performed Regularly</b>		
26	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current.	9
52	Conduct biological emergency response clearance (RSP/detox) over uneven terrain for 2 hr in 70°F temperature and low humidity while wearing a	7

	toxicological agent protective (TAP) suit with ice vest and mask.	
16	Conduct a moving Jackstay grid search at a depth of 50 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period).	6
<b>Muscular Endurance, Ever Performed</b>		
26	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current.	12
47	Set-up equipment (stakes, lines, etc.) and haul a 2,000-lb mine onto beach using blocks, tackle, and four additional EOD technicians (no truck available).	7
16	Conduct a moving Jackstay grid search at a depth of 50 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period).	6
<b>Most Physically Demanding, Regularly Performed</b>		
1	Lift SCUBA tanks (twin-80s weighing 80 lb) to eye level to pass to personnel aboard support craft.	17
62	Carry collapsible chests containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb).	7
26	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current.	6
<b>Most Physically Demanding, Ever Performed</b>		
47	Set-up equipment (stakes, lines, etc.) and haul a 2,000-lb mine onto beach using blocks, tackle, and four additional EOD technicians (no truck available).	14
26	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current.	9
16	Conduct a moving Jackstay grid search at a depth of 50 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period).	6
52	Conduct biological emergency response clearance (RSP/detox) over uneven terrain for 2 hr in 70°F temperature and low humidity while wearing toxicological agent protective (TAP) suit with ice vest and mask.	6

Perhaps the most critical tasks are those the technicians feel everyone in an EOD team should be able to perform. The top three tasks in this category are presented in Table 6. These tasks all

involve partner rescues. EOD is inherently dangerous work, a fact compounded by the hazards involved in diving. It was deemed essential by these technicians that each member of the team be able to perform partner rescues during underwater, surface, and land-based operations.

Table 6. Tasks everyone in an EOD team should be able to perform.

Task #	Task Description	# Respondents
13	Rescue disabled dive partner weighing 185 lb from a depth of 60 feet (both you and your partner wearing twin 80s).	15
17	Pull a disabled diver (weighing approx. 180 lb) into a Mk-5 boat, after releasing the diver's twin 80s and 24 lb of lead weights, without assistance.	12
57	Carry a disabled partner (approx. 185 lb) over shoulder (fireman's carry) to safety (e.g., from blast or toxic fumes, distance approx. 100 yards).	9

### Part Three: Abilities Analysis

Table 7 summarizes the results of the card-sort exercise. The complete list of the ability definitions is included in Appendix A. In contrast to the results presented above, where a higher score indicates a higher ranking, the abilities ranking in Table 7 are scored so that a lower mean value indicates a higher rank relative to other abilities. Eight of the 24 abilities were rated in the "more important" category, including three being physical abilities and five cognitive abilities. Of the three physical abilities, stamina, or the ability to maintain physical activity over prolonged periods of time, was by far the most important physical ability. Possessing physical stamina allows a technician to carry the loads of diving equipment from one location to another, to endure a lengthy limpet inspection under a ship hull, to swim 500 yards on the surface in sea swells and against a current, and to conduct a demanding moving Jackstay grid search.

Manual dexterity, the second highest physical ability, was rated as the fifth most important ability overall, followed closely by strength. Manual dexterity is defined as the ability to make skillful, coordinated hand and arm movements that involve equipment. This is, perhaps, the one ability that most individuals outside the EOD community would associate with RSP and bomb disposal activities.

Strength is required for many of the logistics tasks that technicians perform, including lifting of SCUBA tanks and carrying heavy collapsible chests, footlockers, outboard motors, rubber boats, and other EOD tools and materials. Strength and stamina are also required to

Table 7. Results of the EOD Ability Ranking

More Important Abilities		
1.	Teamwork	3.7
2.	Problem Solving	5.4
3.	Stamina	6.3
4.	Assertiveness	8.1
5.	Manual Dexterity	10.6
6.	Strength	10.6
7.	Oral Comprehension	11.2
8.	Written Comprehension	11.4
Important Abilities		
9.	Oral Expression	13.1
10.	Reaction Time	14.1
11.	Arm-hand Steadiness	14.5
12.	Memory	14.7
13.	Finger Dexterity	14.8
14.	Color Discrimination	15.2
15.	Depth Perception	17.3
16.	Near Vision	17.9
17.	Control Precision	18.2
18.	Spatial Orientation	18.2
19.	Written Expression	18.5
20.	Math Reasoning	18.7
21.	Far Vision	19.5
22.	Peripheral Vision	19.8
23.	Speed of Limb Movement	19.9
24.	Night Vision	20.5
Less Important Abilities		
<i>None listed in this category</i>		

perform emergency rescue tasks, such as rescuing a disabled dive partner from a depth of 60 feet, a surface rescue swim, pulling a disabled diver into a small boat, and the fireman's carry, all rated among the 10 most important tasks that an EOD technician should be able to perform.

The focus of this study was on the most physically demanding EOD tasks and the abilities necessary to perform them. However, it is important to note that several cognitive abilities were judged very important to successful performance as an EOD technician. In particular, teamwork, problem solving, and assertiveness were rated as first, second, and fourth most important abilities, respectively. Teamwork was rated by far the most important EOD ability. The operational definition of teamwork provided was "the ability to work with others as part of a team, to anticipate what others want or need, and to cooperate." The second most important

ability was problem solving, "the ability to perceive small details and size up situations quickly and accurately, then respond with an appropriate course of action." As described in the Introduction, a large portion of EOD work involves small groups working closely together to develop creative solutions to potentially dangerous problems. It is clear that, to achieve success, teamwork and problem solving are critical.

The third highest ranked cognitive ability, assertiveness, was defined as "the ability to bring a problem or important information to the attention of another crew member." This ability is an essential component of good teamwork and is necessary to reduce the normal barriers to communication imposed by differences in rate, rank, or status within a team. An EOD technician, regardless of rank, must be able to call a problem, or potential problem, to the attention of an officer or senior technician. The consequences of inhibited communication among EOD personnel can be life-threatening.

Two additional cognitive abilities were judged as being more important, both related to the need for precision when dealing with explosive devices. Oral comprehension and written comprehension were rated the seventh and eighth most important abilities. Good oral comprehension is necessary to follow the instructions of another EOD technician who is reading aloud the steps for a RSP on a piece of ordnance or to understand another technician's comments or suggestions regarding an action. Written comprehension is necessary for the technician who is reading the procedures from a manual. Documentation of technical specifications and procedures is a cornerstone of all EOD operations. Even today, technicians routinely encounter ordnance from the World War II era. With the wide variety of ordnance a technician may encounter, it is impossible to memorize all the technical aspects of every explosive device. Reliance on technical documentation and comprehension of written information is essential.

### **Conclusions**

This study was conducted to address issues related to the physical fitness standards for EOD personnel. Presently, EOD personnel are required to meet not only general fleet standards, but also meet higher standards established by their command. Some members of the EOD community attributed the absence of uniform higher physical fitness standards to the emphasis that is placed on the team concept in EOD. Viewing the entire unit as a team (including support staff), required unit physical training programs be designed to meet fleet standards, not to meet the physical demands placed on the EOD technician. It was not within the scope of this study to evaluate the current levels of physical conditioning of current EOD personnel. That task was undertaken in the second part of this project. The results of this task analysis were used to select and develop model physical tasks to evaluate existing physical readiness standards for EOD personnel. The results of that study are presented elsewhere (Hodgdon et al., 1998).

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## APPENDIX A

## SKILLS AND ABILITIES

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### CATEGORIES

Category 1 - MORE IMPORTANT: The skills and abilities in this category are *exceptionally important* to the successful performance of my job.

Category 2 - IMPORTANT: The skills and abilities in this category are *important* to the successful performance of my job.

Category 3 - LESS IMPORTANT: The skills and abilities in this category are *less important* to the successful performance of my job.

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### ABILITIES

Ability	Definition
Spatial Orientation:	The ability to maintain orientation with respect to objects when you or the objects are moving.
Reaction Time:	The speed with which a single motor response can be made following the onset of a single stimulus.
Control Precision:	The ability to make fine adjustments to a knob or dial.
Arm-Hand Steadiness:	The ability to make precise, steady arm-hand positioning movements.
Manual Dexterity:	The ability to make skillful, coordinated movements of a hand together with its arm--may involve equipment, but not equipment controls.
Finger Dexterity:	The ability to make skillful, coordinated movements of the fingers--may involve equipment, but not equipment controls.
Speed of Limb Movement:	The speed with which movements of the arms or legs can be made; the speed with which the movement can be carried out after it has been initiated.
Strength:	The amount of muscular force that can be exerted.

Stamina:	The ability to maintain physical activity over prolonged periods of time.
Near Vision:	The ability to see close environmental surroundings.
Far Vision:	The ability to see distant environmental surroundings.
Night Vision:	The ability to see under low light conditions.
Color Discrimination:	The ability to match or discriminate between colors.
Peripheral Vision:	The ability to perceive objects or movement towards the edges of the visual field.
Depth Perception:	The ability to distinguish which of several objects is nearer or more distant, or to judge the distance to an object.
Oral Comprehension:	The ability to understand spoken English words or sentences.
Written Comprehension:	The ability to understand written sentences and paragraphs.
Oral Expression:	The ability to speak English words or sentences so others will understand.
Written Expression:	The ability to write English words or sentences so others will understand.
Memorization:	The ability to remember information, such as words, numbers, pictures, and procedures.
Math Reasoning:	The ability to understand and organize a problem and then to select a mathematical method or formula to solve the problem.
Teamwork:	The ability to work with others as part of a team, to anticipate what others want or need, and to cooperate.
Assertiveness:	The ability to bring a problem or important information to the attention of another crew member in a timely fashion.
Problem Solving:	The ability to perceive small details and "size-up" situations quickly and accurately, then respond with an appropriate course of action.

## **APPENDIX B**

## Responses to the EOD Survey of Physically Demanding Tasks

Survey questions are listed in the order in which they appeared in the questionnaire. Values are means (rank out of 64) for difficulty to perform (D), importance to mission success (I), frequency performed (F) dimensions, and the composite (C) score.

	<b>Task Statement</b>	<b>D</b>	<b>I</b>	<b>F</b>	<b>C</b>
1	Lift SCUBA tanks (twin-80s weighing 80 lb) to eye level to pass to personnel aboard support craft.	4.58 (51)	5.79 (14)	6.37 (2)	16.74 (1)
2	Carry diving equipment from truck or dive locker to a small boat (six trips at 60 lb each).	3.79 (62)	5.62 (21)	6.42 (1)	15.83 (4)
3	Move a 370-lb depth charge into position, using a floatation bladder and with another EOD technician, to blast a channel in a coral reef.	5.04 (35)	4.13 (60)	1.51 (62)	10.68 (63)
4	Move a practice torpedo from its position lodged in a coral reef a distance of 200 yards to shore, in tropical weather, using block and tackle, with three other EOD technicians.	5.59 (18)	4.71 (50)	2.00 (56)	12.30 (55)
5	Perform a limpet inspection of a Spruance-class destroyer, at night while carrying a 10-lb bag of tools, with partner (approx. 1- to 3-hr duration).	4.60 (50)	6.21 (7)	5.11 (4)	15.92 (2)
6	Assist ship's husbandry divers in replacing a Spruance-class destroyer propeller using EOD SCUBA gear.	5.04 (36)	3.69 (64)	1.53 (61)	10.26 (64)
7	Assist ship's husbandry divers in securing a 6-foot square aluminum patch to the hull of a Spruance-class destroyer in 6-foot swells.	5.50 (21)	4.07 (61)	1.71 (58)	11.28 (62)
8	Dive to a depth of 60 feet to bring then attach a Mk II lift balloon to a bottom mine, then return to boat against a 1-knot current in 4-foot seas, remove UBA and weights, and pass them to person onboard; then, pull self aboard.	5.07 (32)	6.08 (9)	4.39 (10)	15.46 (5)
9	Swim 150 feet to a floating mine, in 4-foot swells with a charge (20-lb), attach the charge, and swim away quickly to waiting "horse collar" for helicopter retrieval.	4.67 (49)	6.22 (6)	3.52 (35)	14.41 (28)
10	Use pinger/receiver to locate mines, then move	5.10	5.39	3.99	14.48

	"clumps" (approx. 60 lb each) to recover 10 training mines from muddy bottom in a 4-hr period.	(31)	(29.5)	(21)	(24)
11	Swim to a bottom mine with Mk-16 UBA (depth 180 feet) in calm seas, attach lifting balloon, and then swim away to vessel.	3.82 (61)	5.87 (11)	3.46 (37)	13.15 (47)
12	Swim to a bottom mine with twin 80s SCUBA gear (depth 60 feet) in calm seas, attach lifting balloon, and then swim away to vessel.	3.61 (63)	5.70 (15.5)	3.91 (24)	13.22 (45.5)
13	Rescue disabled dive partner weighing 185 lb from a depth of 60 feet (both you and your partner wearing twin 80s).	5.45 (22)	6.87 (1)	1.40 (64)	13.72 (40)
14	Retrieve a dead body from a crashed airplane at a depth of 130 feet, while wearing a Mk-16 UBA.	4.88 (41)	4.93 (48)	1.48 (63)	11.29 (61)
15	Swim on calm sea surface a distance of 100 yards with disabled dive partner weighing 185 lb who is wearing an inflated life preserver.	4.85 (42.5)	6.60 (2)	1.54 (60)	12.99 (48)
16	Conduct a moving Jackstay grid search at a depth of 50 feet and with ½-knot current, while carrying an ordnance locator in one hand and moving a 100-lb clump (heavy due to current) 6-foot increments (approx. 50 times during a 2-hr period).	6.00 (4)	5.51 (25)	3.53 (34)	15.04 (7.5)
17	Pull a disabled diver (weighing approx. 180 lb) into a Mk-5 boat, after releasing the diver's twin 80s and 24 lb of lead weights, without assistance.	5.12 (30)	6.47 (3)	2.14 (53)	13.73 (39)
18	Pull a disabled diver into a Mk-5 boat, with diver wearing a wet suit, a set of twin 80s, and 24 lb of lead weights (approx. 280-lb total), with assistance.	5.61 (16)	6.27 (5)	2.13 (54)	14.01 (33)
19	Climb a 50-foot Jacobs's ladder or cargo net to board a ship from a rubber boat while wearing a wet suit and carrying 50 lb of equipment in a pack.	5.23 (27)	5.11 (42)	3.12 (43)	13.46 (41)
20	Climb a 50-foot Jacobs ladder or cargo net to board a ship from a rubber boat while wearing a wet suit and controlling a disabled dive partner who is being hoisted aboard with a "horse collar."	5.58 (19)	5.64 (20)	1.64 (59)	12.86 (52)
21	Climb a Jacobs ladder 15 feet into a helicopter from the sea, while carrying fins and 50 lb of gear.	5.62 (15)	5.37 (32)	3.06 (44)	14.05 (31)

22	Lower and empty rubber boat, weighing approx. 200 lb, from the elevator of an aircraft carrier, by hand with three other EOD technicians, but no block and tackle.	5.02 (37)	5.00 (46)	3.40 (40)	13.42 (42)
23	Lift twin 80s SCUBA gear with a lift balloon attached (approx. 100 lb) to eye level to load aboard a boat, with a partner.	4.83 (44)	5.49 (26)	4.30 (15.5)	14.62 (20.5)
24	Carry a total of twelve 200-cubic foot "K" bottles (one at a time; 150 lb each) a distance of 60 feet, with a partner.	4.51 (52)	3.94 (62)	3.19 (42)	11.64 (59)
25	Serve as an emergency breathing system (EBS) tender on a Mk-16 decompression dive (e.g., bending over to watch for the tape markers and pulling line at a rate of 1 foot per second with nine stops (line, clump, and weight of divers is equivalent of 50 lb).	3.95 (58.5)	5.86 (12)	4.15 (18)	13.96 (34)
26	Swim on surface a distance of 500 yards, wearing a full wet suit, twin 80s, a partially-inflated life vest, and fins in 4-foot swells and against a 1-knot current.	6.17 (1)	5.36 (33)	3.45 (38)	14.98 (10)
27	Lift marine mammal target (approx. 100 lb) over side of boat with another EOD technician.	3.85 (60)	4.33 (57)	4.30 (15.5)	12.48 (53)
28	Haul in 500 feet of line by hand with 24-lb weights attached at end (15 times during a 4-hr period).	4.73 (48)	4.52 (54)	4.10 (19)	13.35 (44)
29	Pass YB (target buoy approx. 65 lb) from boat to animal and recover YB from animal.	3.95 (58.5)	4.66 (52)	4.37 (11.5)	12.98 (49)
30	Enter water from boat wearing twin 80s to verify correct YB action for animal reward (approx. 40-foot depth) and return to boat (pulling self aboard), 20 times in a 2-hr period.	4.78 (47)	5.09 (44)	4.65 (6)	14.52 (22)
31	Unload two hundred fifty 40-lb cartons of frozen marine mammal food (10,000-lb total) from truck to storage with six other EOD technicians (bucket-brigade style).	4.16 (56)	4.20 (59)	4.58 (8)	12.94 (50.5)
32	Haul a 450-lb marine mammal aboard a small boat with two other EOD technicians.	5.05 (34)	5.10 (43)	4.33 (14)	14.48 (24)
33	Perform a parachute drop into calm sea from helicopter (approx. 2,500 feet) towing a buoyant 40-lb pack, swim 200 feet to a rubber boat, and then pull self and gear aboard.	4.79 (46)	5.59 (22)	4.09 (20)	14.47 (26)

34	Jump from helicopter into calm sea (approx. 25 feet), and then swim 100 yards to shore against a ½-knot current, towing a 40-lb pack and an M-16.	5.05 (33)	5.32 (34)	3.82 (27)	14.19 (29)
35	Fast-rope onto deck of ship (from height of 30 feet) carrying a 40-lb pack.	3.99 (57)	5.53 (23.5)	4.26 (17)	13.78 (37.5)
36	Serve as fast rope master at door of helicopter for three drops during a day, pulling 50-lb rope into helo between drops.	4.24 (54)	5.28 (35)	4.51 (9)	14.03 (32)
37	Carry equipment bags (with sledges, stakes, vests, etc; weighing 60-lb) while trailing the remote pull line with additional equipment bag attached (approx. 1,000 feet).	4.85 (42.5)	5.53 (23.5)	4.63 (7)	15.01 (9)
38	Carry 20 sandbags (40-lb each), two at a time, a distance of 30 feet (i.e., 2 bags x 10 trips) in 80°F temperature and high humidity.	4.80 (45)	4.63 (53)	4.35 (13)	13.78 (37.5)
39	Dig with shovel in hard-packed soil to a depth of 10 feet to expose a buried bomb for removal (in 80°F temperature and high humidity).	5.60 (17)	4.98 (47)	2.64 (47)	13.22 (45.5)
40	Lift a 50-kg bomb from a hole using block and tackle, with a partner.	4.36 (53)	4.67 (51)	2.45 (51)	11.48 (60)
41	Carry a 50-kg bomb 100 feet on level terrain using "hernia bar," with a partner.	4.99 (39)	4.28 (58)	2.60 (48)	11.87 (57)
42	Lift a 100-kg bomb from a hole using block and tackle, with a partner.	4.95 (40)	4.48 (55)	2.48 (50)	11.91 (56)
43	Carry a 100-kg bomb 100 feet using "hernia bar," with a partner.	5.41 (23)	4.40 (56)	2.51 (49)	12.32 (54)
44	Drag one hundred 250-kg bombs through a swamp (distance approx. 100 feet) using block and tackle, with another EOD technician.	6.12 (2)	3.83 (63)	1.75 (57)	11.70 (58)
45	Drag a Zodiac rubber boat with twin 25-hp motors attached and four 60-lb packs inside, through the surf zone and onto the beach 100 feet, then turn the boat around, with three other EOD technicians.	5.73 (12)	5.27 (36)	3.67 (31)	14.67 (18)

46	Swim a buoy out to a floating mine (distance approx. 500 feet) and attach line for rigging mine to beach.	4.19 (55)	5.24 (37)	3.51 (36)	12.94 (50.5)
47	Set-up equipment (stakes, lines, etc.) and haul a 2,000-lb mine onto beach using blocks, tackle, and four additional EOD technicians (no truck available).	5.92 (7)	5.69 (17)	3.05 (45)	14.66 (19)
48	Walk at a quick pace over uneven terrain a distance of 5 miles in 90°F temperature and high humidity, carrying a 40-lb pack of EOD equipment and an M-16.	5.39 (24)	5.42 (27)	3.81 (28)	14.62 (20.5)
49	Move rapidly 100 yards in sand while wearing a 40-lb pack and carrying an M-16 (while receiving enemy fire).	5.67 (13.5)	5.70 (15.5)	2.01 (55)	13.38 (43)
50	Conduct conventional range clearance over uneven terrain for 4 hr in 100°F temperature with low humidity (e.g., Fallon) carrying a 40-lb pack.	5.20 (28)	5.64 (19)	3.86 (26)	14.70 (16)
51	Conduct conventional range clearance over uneven terrain for 4 hr in 85°F temperature and high humidity (e.g., Kahoolawe) while carrying a 40-lb pack.	5.15 (29)	5.67 (18)	3.98 (22)	14.8 (13.5)
52	Conduct biological emergency response clearance (RSP/detox) over uneven terrain for 2 hr in 70°F temperature and low humidity while wearing toxicological agent protective (TAP) suit with ice vest and mask.	5.99 (5)	5.41 (28)	3.28 (41)	14.68 (17)
53	Conduct nuclear emergency response clearance over uneven terrain for 4 hr in 90°F temperature and low humidity while wearing Anti-C protective coveralls and mask and carrying a 20-lb pack.	5.51 (20)	5.38 (31)	3.57 (33)	14.46 (27)
54	Don protective ensemble and approach IED aboard ship (approx. distance 300 feet with two ladders to climb) carrying x-ray equipment and tool kit.	4.99 (38)	6.02 (10)	4.37 (11.5)	15.29 (6)
55	Set-up and operate x-ray equipment on suspected IED (with moderate access).	2.81 (64)	6.10 (8)	5.19 (3)	14.10 (30)
56	Perform IED response wearing full protective ensemble and carrying a J-rod and a .50 caliber dearmmer (one in each hand a arm's length from body), a firing reel, and tool kit a distance of 300 feet over level terrain in 85°F temperature and low humidity.	5.27 (26)	5.83 (13)	4.77 (5)	15.87 (3)

57	Carry a disabled partner (approx. 185 lb) over shoulder (fireman's carry) to safety (e.g., from blast or toxic fumes, distance approx. 100 yards).	5.89 (9.5)	6.39 (4)	2.20 (52)	14.48 (24)
58	Carry a footlocker containing EOD technical manuals (approx. 220 lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), with a partner, in preparation for deployment.	5.90 (8)	5.14 (41)	3.88 (25)	14.92 (11)
59	Carry a 25-hp outboard motor (approx. 60-lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), in preparation for deployment.	5.67 (13.5)	5.20 (39)	3.93 (23)	14.80 (13.5)
60	Carry a 40-hp outboard motor (approx. 110-lb) from truck on dock to compartment aboard an aircraft carrier (3 levels down), with a partner, in preparation for deployment.	5.98 (6)	5.18 (40)	3.67 (32)	14.83 (12)
61	Carry an F470 rubber boat, deflated (approx. 200 lb), from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment.	5.81 (11)	5.23 (38)	3.75 (30)	14.79 (15)
62	Carry collapsible chests containing EOD equipment and documents from truck on dock to compartment aboard an aircraft carrier (3 levels down), with three other EOD technicians, in preparation for deployment (a total of eight chests weighing 150 to 220 lb).	5.89 (9.5)	5.39 (29.5)	3.76 (29)	15.04 (7.5)
63	Run 1 mile over beach and sand dunes, sprinting from cover to cover with 2-min resets between the 20- to 50-yard sprints, while wearing a 40-lb pack and carrying an M-16 in 85°F temperature and high humidity.	6.01 (3)	4.77 (49)	3.02 (46)	13.80 (35)
64	Conduct land navigation over uneven terrain for 4 hr in 100°F temperature and low humidity, while carrying a 40-lb pack, an M-16, and a sidearm.	5.33 (25)	5.04 (39)	3.42 (39)	13.79 (36)

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The primary objective of this study was to identify physically demanding tasks performed during EOD operations and rank them according to difficulty to perform, frequency of performance, and importance to mission success. Subject matter experts from EOD units were interviewed regarding tasks they perform or had performed as EOD technicians. Following an iterative review and revise process, an inventory was developed and judged comprehensive and technically accurate. We developed a three-part questionnaire based on the tasks. A total of 84 technicians from EOD Groups ONE and TWO completed the survey. The years of EOD experience of this sample ranged from 1 to 26.5 years, with a mean ( $\pm$  SD) of 9 ( $\pm$  2) years. The top rated tasks were logistics tasks of loading diving equipment onto a support craft. The three tasks that respondents believed every EOD team member should be able to perform were partner rescues. These data comprise the most comprehensive analysis of the physical demands of actual EOD tasks performed to date. Logistics tasks appear to be among the most physically demanding and frequently performed. These data provide a basis for developing job-based fitness standards and may be used to develop physical training programs for EOD technicians.

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